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Peers Increase Adolescent Risk Taking Even When the Probabilities of Negative Outcomes Are Known

Ashley R. Smith, **Jason Chein**, and **Laurence Steinberg**
Temple University

Abstract

The majority of adolescent risk taking occurs in the presence of peers, and recent research suggests that the presence of peers may alter how the potential rewards and costs of a decision are valuated or perceived. The current study further explores this notion by investigating how peer observation affects adolescent risk taking when the information necessary to make an informed decision is explicitly provided. We used a novel probabilistic gambling task in which participants decided whether to play or pass on a series of offers for which the reward and loss outcome probabilities were made explicit. Adolescent participants completed the task either alone or under the belief that they were being observed by an unknown peer in a neighboring room. Participants who believed a peer was observing them chose to gamble more often than participants who completed the task alone, and this effect was most evident for decisions with a greater probability of loss. These results suggest that the presence of peers can increase risk taking among adolescents even when specific information regarding the likelihood of positive and negative outcomes is provided. The findings expand our understanding of how peers influence adolescent decision making and have important implications regarding the value of educational programs aimed at reducing risky behaviors during adolescence.

Keywords

adolescence; peer influence; risk taking

Adolescence is a period of heightened involvement in risky and reckless behavior, much of which occurs in the presence of peers. Both epidemiological and experimental studies indicate that adolescents take more risks when in the presence of their peers than when they are alone (Gardner & Steinberg, 2005) or in the presence of older individuals (Simons-Morton et al., 2011). This phenomenon, known as the peer effect, is not observed among adults (for reviews, see Albert & Steinberg, 2011; Albert, Chein, & Steinberg, 2013). The presence of peers also increases adolescents' stated preference for engaging in risk taking, their likelihood of endorsing risky choices in hypothetical decision making scenarios, and the extent to which they emphasize the potential benefits of risky activities relative to their potential costs (Gardner & Steinberg, 2005).

Correspondence concerning this article should be addressed to Ashley R. Smith, Temple University, Department of Psychology, 6th Floor Weiss Hall, 1701 North 13th Street, Philadelphia, PA 19122. ashley.r.smith@temple.edu.
Ashley R. Smith, Jason Chein, and Laurence Steinberg, Department of Psychology, Temple University.

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Over the past several years researchers have examined possible mechanisms through which peers incline adolescents' decision making toward riskier choices. Based on our prior research, we have suggested an account of peer influence whereby the presence of peers activates the brain's reward circuitry more significantly during adolescence than in adulthood, increasing individuals' sensitivity to the potential immediate rewards of a risky choice. In order to examine the underlying neural mechanism for the peer effect on adolescent risk taking, Chein, Albert, O'Brien, Uckert, and Steinberg (2011) employed functional magnetic resonance imaging to contrast patterns of brain activity among adolescents and adults who played a video driving game either with or without two friends observing their performance. In the presence of peers, adolescents (but not adults) evinced both higher levels of risky driving (i.e., attempting to drive through intersections after a traffic signal had turned yellow, despite not knowing whether they might crash into another car that is crossing the intersection at the same time) and increased activation of brain regions specifically associated with the prediction and valuation of rewards, including the ventral striatum and orbitofrontal cortex. As further evidence that the peer effect influences the valuation of immediate rewards, we have found that peer observation can impact the subjectively perceived value of immediate relative to delayed rewards, both when the peers are known friends (O'Brien, Albert, Chein, & Steinberg, 2011), and when an unknown individual identified as being of the same sex and approximate age (Weigard, Chein, Albert, Smith, & Steinberg, 2014) are the observers. A recent test of the peer effect on reward sensitivity using a rodent model found that juvenile mice, but not adult mice, consume more alcohol in the presence of "peers" than when alone, suggesting that the impact of peers on adolescents' reward sensitivity may be a hard-wired feature of adolescence that has been conserved across species (Logue, Chein, Gould, Holliday, & Steinberg, 2014).

Real-world risk taking often occurs in situations where the individual has little information about the likelihood of alternative outcomes (e.g., when running a yellow light to cross through an intersection, or diving into an unfamiliar body of water of unknown depth). The influence of peers on decision making in such "information-limited" contexts was explored in the studies by Gardner and Steinberg (2005) and Chein et al. (2011), in which individuals were required to make decisions in the absence of explicit information about when success or failure could be expected. In other circumstances, however, risky choices are made even when the individual possesses information regarding the probabilities of positive and negative outcomes (e.g., when placing a bet, when having unprotected sex with an infected partner). Whether the influence of peers on adolescents' risky decision making extends to such conditions, where the individual has information about the relative probabilities of positive and negative consequences, has not been explored in previous work (e.g., the peer effect may bias adolescents' decision making only when the likelihood of a risky outcome is unknown). Moreover, extant work does not clarify whether the magnitude of the peer effect differs as a function of the likelihood of a negative outcome.

Exploring whether the peer effect extends to decision making under conditions of known probability is of fundamental importance because many intervention programs intended to mitigate adolescent risk taking assume that adolescents can be dissuaded from risky behaviors by providing them with better information about the chances of incurring harm as a consequence of a risky choice. While there is evidence that programs designed to educate adolescents about the dangers of risk taking may be effective in conveying information, their efficacy in actually reducing subsequent risk taking is questionable (Steinberg, 2008). Because adolescents spend such a substantial amount of time around their peers, knowing whether the presence of peers inclines adolescents toward risky decision making even when they are specifically aware of the probabilities of negative outcomes might provide important insights regarding the value of programs aimed at educating adolescents about these probabilities.

In the present study, we examined peer influences on adolescent risk taking under various cost– benefit contingencies using a newly developed probabilistic gambling task (PGT) in combination with a virtual peer manipulation that we developed and described in Weigard et al. (2014). In the task, participants were presented with a series of gambles for which reward and loss probabilities were presented explicitly and were asked whether they would like to bet (take a risk) or pass on the offer. We hypothesized that despite being given complete information regarding the probability of risk and reward, adolescents would choose to gamble more often when they believed that they were being observed by a peer, relative to when completing the task alone. By varying the probability of reward and loss, we were also able to explore whether the impact of a peer observer varied as a function of the relative riskiness of the gamble.

Method

Participants

In the present study, 52 adolescents (23 females), 15–17 years of age (M = 16.17, SD = 0.81), were recruited from a large urban community. Participants were randomly assigned to complete the PGT either with (the “peer” condition; N = 26, 11 females) or without (the “alone” condition; N = 26, 12 females) the belief that a same-aged, same-sex peer was observing their performance from a neighboring room. The demographics were as follows: 74% Black, 10% White, 7% Hispanic, 5% unknown, 4% Asian. The two groups did not differ in age, $t(50) = 0.85$, $p = .40$, gender, $\chi^2(1, N = 52) = 0.08$, $p = .78$, race, $\chi^2(2, N = 52) = 1.67$, $p = .44$, or ethnicity, $\chi^2(2, N = 52) = 0.53$, $p = .77$. Six participants were excluded from the analyses because their performance indicated that they did not understand the task (i.e., despite obvious differences between favorable and unfavorable trials, described below, these participants’ decisions to play or pass did not vary as a function of the favorability of the gamble).

Procedure

The study was part of a larger fMRI project, and behavioral data were collected while participants were situated in an MRI scanner. While in the scanner, participants completed three 8-min rounds of the PGT (described below) and two 5-min runs of a response inhibition task. The order of tasks was the same for all participants, beginning with PGT and alternating between the two tasks. The response inhibition task is not discussed in this article.

Participants were randomly assigned to complete the study test battery either alone or with the understanding that their performance was being observed by a peer. Those in the peer condition were told that another adolescent of the same gender (who was volunteering for the research, like themselves), seated in a different room in the building, would be observing their performance on a battery of computer tasks via a closed-circuit computer system and making predictions about how they would perform. Participants were told that in order to help the observer make predictions, the observer and the participant would engage in a brief introductory exchange over an intercom. In reality, there was no observer, and the exchange between the participant and observer used a prerecorded audio file. During the exchange, one of two voice recordings (one for each gender) was played: "Hey, my name is John [Jess, for female participants], I'm [participant's age] years old. My favorite color is blue, and I was born in Philadelphia." The researcher explained that the purpose of the study was simply to see if the observer could make accurate predictions about the player's performance without physically meeting the observed participant. Participants were told that they would meet the observer at the end of the study (further details of the interaction are described in Weigard et al., 2014).

Following the social exchange, participants began the tasks. To remind the participant of the peer observer, the participant was told before each run of the task that the experimenter would individually ask both the observer and the participant if they were ready to begin the task procedure. The experimenter asked, over the intercom, if the participant was ready to begin the task, and subsequently asked the observer if he or she was finished making predictions and ready for the participant to begin. The observer's prerecorded response, played over the intercom, was a simple confirmation each time: (e.g., "OK, I'm ready now"; "I'm good, go ahead"). To establish that only the anonymous peer was observing the participant (i.e., that the experimenter was not observing the participant), the experimenter informed the participant that he or she would be located in a separate area next to the testing room and did not have access to the closed circuit viewing system.

In the alone condition, participants completed the same tasks without any reference to an observer. As in the peer condition, participants in the alone condition were told that the experimenter would not be able to observe the participant's performance. Participants were debriefed via a mailed letter following completion of study to ensure no communication of the manipulation among participants.

Task

On each trial of the probabilistic gambling task (PGT), the participant was presented with a wheel that was divided into three distinct pie-shaped sections, colored red, green, and gray. The green section indicated the participant's opportunity to win tokens (reward, +10 tokens), red indicated the opportunity to lose tokens (loss, −10 tokens), and grey indicated the chance of neither winning nor losing tokens (neutral outcome, 0 tokens). It was explained that the relative size of each section was exactly indicative of the chance of landing on that section and achieving the specified outcome (see Figure 1).

Each participant began the task with a bank of 100 tokens. On each trial, participants were shown a wheel and asked to think for 2000 ms about whether they would like to play (and

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accept the outcome of the wheel's spin) or pass (move on to the next wheel). Next, the words "Play or Pass?" appeared above the wheel, and participants were required to make their selection within 1500 ms. Participants were not asked to decide how much to wager; each wheel that was played could result in a loss of 10 tokens, a gain of 10 tokens, or no change in the number tokens. At the beginning of each round, participants were told that the outcome of each round was completely independent of prior rounds.

If the participant chose to play on a wheel, the wheel began spinning and came to rest with an indicator pointing to one of the three sections. If the participant chose to pass, a screen indicating "no play" appeared. After each trial, a feedback screen appeared; participants were shown the trial's outcome (+10 for a win, −10 for a loss, and 0 for a neutral or pass) and their overall game earnings up to and including that wheel. All participants completed an instructional session with the researcher, followed by a practice session consisting of 10 wheels. Participants played three 8-min rounds of 42 wheels each, either under the impression that there was an anonymous peer observer in a nearby room or that there was no observer at all.

Six different gain-to-loss probability ratios, ranging from 1.5 to 0.33, were used in the task (see Figure 2). The neutral portion of the wheel was always fixed at either 50% or 10%, and the variably sized gain and loss sections completed the wheel. The rewarding portion of the wheel (i.e., green section) was alternated between being presented on the right or left side of the wheel in a randomized order. Risk taking was measured by the percentage of plays of each wheel type.

Results

Across the six wheel types, participants in both conditions behaved in a systematic and predictable fashion, indicating that they understood the task contingencies. Specifically, participants played more often when presented with higher gain-to-loss probabilities and decreased the percentage of plays as the probabilities decreased (when the gain-to-loss probability was 1.5:1, M = 82.67%, SD = 19.38; at 1:1, M = 65.44%, SD = 29.84; at 0.81:1, M = 33.22%, SD = 28.25; at 0.67:1, M = 24.46%, SD = 23.48; at 0.50:1, M = 11.96%, SD = 15.56; at 0.33:1 M = 8.02%, SD = 12.62). As noted earlier, six participants whose choices indicated that they did not understand the task (i.e., who consistently played unfavorable wheels more than favorable ones) were excluded from the analyses.

A 2 ×6 (Social Context ×Gain-Loss Probability) repeated-measures analysis of variance was conducted with social context (alone, peer) as a between-subjects variable and wheel type (1.5, 1, 0.81, 0.67, 0.50, 0.33) as a within-subject variable. The six probability ratios were not evenly spaced; therefore, coefficients were included in the model to specify the spacing between wheel types (1.5, 1, 0.81, 0.67, 0.50, 0.33). There was a main effect of wheel type on decisions, $F(5, 220) = 131.29$, $p < .01$; as the gain-to-loss ratio decreased so did the percentage of plays, with both linear, $F(1, 44) = 452.31$, $p < 0.01$, and cubic, $F(1, 44) = 33.36$, $p < .01$, trends. There was also a main effect of social context on decisions, $F(1, 44) = 7.19$, $p = .01$; adolescents who believed they were being observed were more likely to play

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than adolescents who did not believe that a peer was present. The interaction between social context and wheel type was not significant, $F(5, 220) = 1.318$, $p = .26$.

Although the omnibus interaction was not significant, to further explore the possibility that peer observation differentially affects decisions as a function of outcome probabilities, we conducted independent samples *t* tests assessing the influence of social context on decision making at each probability ratio. There were no differences in the percentage of wheels played in the peer and alone conditions for the three most favorable wheel types: 1.5, $t(44) = 0.75$, $p = .47$, $d = 0.22$; 1, $t(44) = 1.44$, $p = .16$, $d = 0.43$; and 0.81, $t(44) = 1.10$, $p = .28$, $d = 0.33$. However, believing that one was observed by a peer significantly impacted the percentage of plays for all three of the lower gain–loss probabilities (0.67, $t(44) = 3.57$, $p = .001$, $d = 1.05$; 0.50, $t(44) = 2.88$, $p = .006$, $d = 0.87$; and 0.33, $t(44) = 2.34$, $p = .02$, $d = 0.72$), with increased risk taking exhibited by those in the peer condition (see Figure 3).

Discussion

Prior studies have shown that, under conditions of uncertainty, adolescents are more likely to take risks when with their peers than when they are alone. The present results demonstrate that this peer effect on adolescents' risky decision making can be demonstrated even when individuals are given specific information about the probability that a risky decision will result in a positive or negative outcome. Although adolescents did evince less frequent risk taking for riskier than safer gambles, being observed by peers altered this pattern. Because adolescents' behavior in both social conditions followed a rational pattern, with risk taking increasing linearly as a function of the favorability of the gamble, and because the observer did not communicate with the participant during the task, it is unlikely that the impact of the peer observer was simply a form of mental distraction (if it were, we would expect to see less logically systematic responding). Instead, the pattern of results is consistent with the idea that that the presence of peers changes the way in which adolescents perceive or evaluate the relative rewards and costs of a risky choice. Although the participants were tested while inside an MRI scanner, our previous studies have demonstrated that this does not amplify or attenuate the peer effect on risky decision making (Chein et al., 2011).

Past research has suggested that peers influence adolescents' decision making by increasing their sensitivity to the rewarding aspects of a risky choice (e.g., Chein et al., 2011), but no prior study of the peer effect assessed decision making with known outcome probabilities, or explicitly varied the amount of risk involved in the decision. To our knowledge, this is the first study to demonstrate that the peer effect on adolescent risk taking is not limited to situations in which the outcome of a risky choice is entirely uncertain. Although we found that the presence of peers increases risk taking regardless of the relative riskiness of a decision, we explored whether the strength of the peer effect also varies as a function of the probability of a negative outcome. This exploratory analysis showed that the peer effect might be most powerful when the risk inherent in a choice is either ambiguous or substantial (i.e., the impact on decisions with more favorable outcomes may be weaker). Put differently, the influence of peers on adolescents' risk taking may actually be strongest when a potentially negative outcome of making a risky choice is relatively more likely. Whether a similar pattern is seen among older or younger individuals is a question that should be addressed in future studies.

In most previous studies of the peer effect on adolescent risk taking (Chein et al., 2011; Gardner & Steinberg, 2005), the peer observers were the adolescents' friends; consequently, it was not possible to determine whether the impact of peers was limited to situations in which the adolescents knew the people who were observing their choices. In the current study, we demonstrate that the peer effect on risky decision making is not limited to the influence of individuals who are known by the adolescent, a result consistent with the finding that observation by an anonymous peer increases adolescents' preference for immediate rewards (Weigard et al., 2014). The fact that observation by unfamiliar peers increases adolescents' inclination to make risky choices may have especially important implications for understanding adolescent risk taking even when peers are encountered via digital media (e.g., over the Internet), where interactions with unfamiliar peers are likely to be more common than they are in face-to-face interactions. Future research might examine factors that explain individual differences in susceptibility to this effect.

The use of the virtual peer paradigm has important methodological as well as substantive implications. Specifically, the procedure provides experimenters with a higher level of control over the substance of the peer interactions, so that the extent to which peers are approving, neutral, or disapproving of risky choices can be experimentally manipulated (in the present study, we did not attempt to directly influence the participant through manipulation of observer characteristics). In addition, although the virtual peer in the present study was described as the same age and gender as the participant (so that this experiment would be consistent with past studies), the use of this paradigm also permits the experimenter to manipulate other variables that may be important influences on social interactions, such as the age, gender, ethnicity, and status of the observer, as well as whether the adolescent is being "observed" by a single individual or by several. Thus, the use of an anonymous, virtual peer manipulation allows researchers to examine the specific qualities of peer interactions that increase or diminish risk taking during adolescence and that therefore may inform the design and implementation of interventions aimed at reducing risky behavior.

The current study suggests that the presence of peers increases risky decision making during adolescence even when explicit information about the probability of negative outcomes is provided, and even (perhaps especially) when these negative outcomes are portrayed as highly likely. The fact that peers increase adolescent risk taking not only when the outcomes of a risky choice are unknown but also when concrete information about the probability of negative outcomes is provided may have important implications for educational programs designed to diminish risky behavior by providing adolescents with information about the riskiness of certain activities. Specifically, our results yield evidence that providing adolescents with information about the likelihood of negative outcomes may not be as effective as might be expected when the targeted behaviors are those that tend to occur when adolescents are with their peers, such as substance use, reckless driving, or unprotected sex. This may help explain why so many of the educational interventions designed to reduce adolescent risk taking, much of which takes place in social settings, have proven to be only marginally effective.

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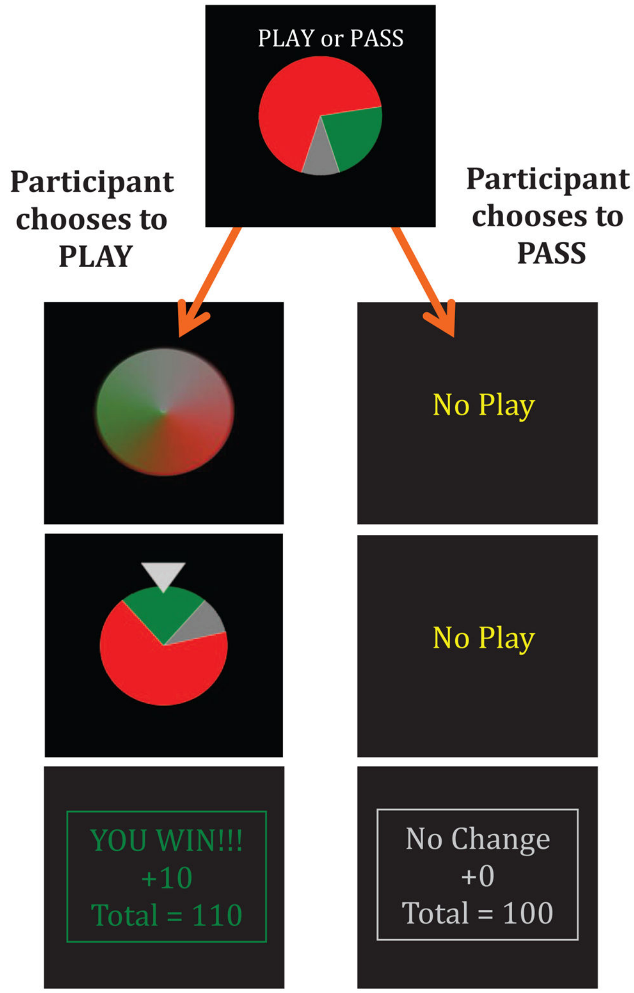

Figure 1.

Probabilistic gambling task. In the task, participants decided whether to play or pass on the wheel on the basis of the gain-to-loss probability ratio (which was visually presented by the colored sections of the wheel). If the participant chose to play, the wheel spun and then landed on one of the three wheel sections (gain, loss, neutral). If the participant chose to pass on the offer then a screen showing “no play” appeared. Finally, a feedback screen appeared, and participants were shown the current trial earnings and their overall game earnings.

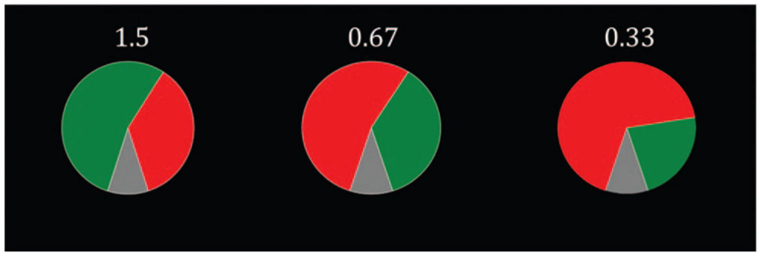

Figure 2.
Gain-to-loss probabilities. Six different gain-to-loss probabilities were used in the task: 1.5, 1.0, 0.81, 0.67, 0.50, and 0.33, ranging from favorable to unfavorable odds. The green and red sections of the wheel were counterbalanced on the right and left side of the screen. Three examples are presented.

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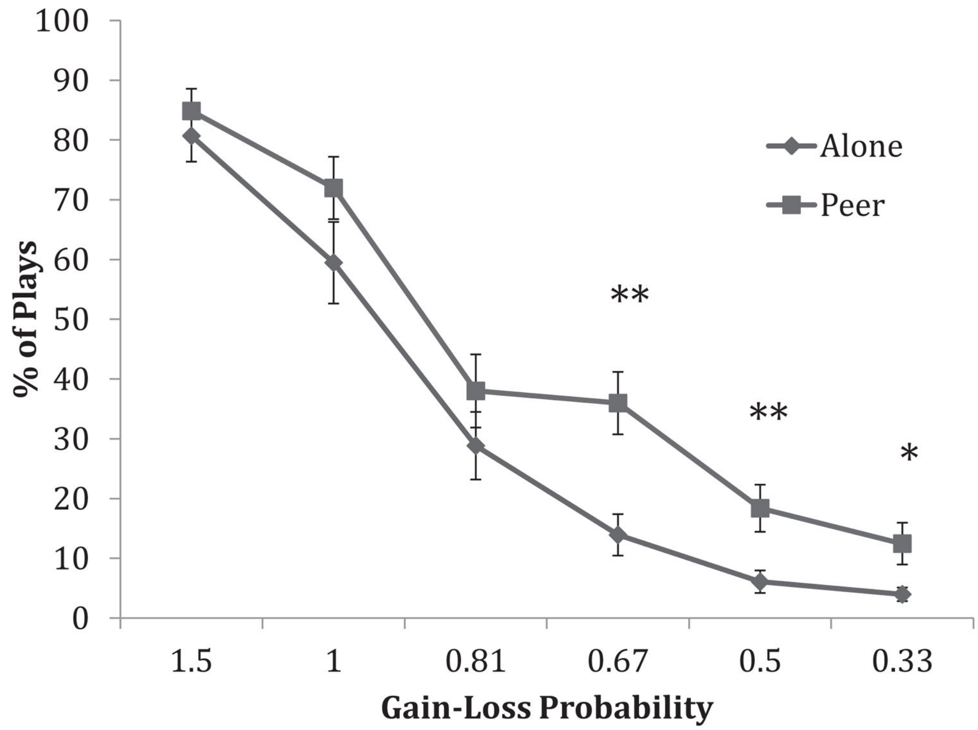

Figure 3.

Percentage of plays by social context. Participants increased risk-taking behavior when they believed an anonymous peer was observing them, specifically as the gain-to-loss probability of the wheel types decreased. Error bars are standard errors. * $p < .05$. ** $p < .01$.